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Substation Foundations | Case History : Helical piles Basin Electric Cooperative

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The busses were at an angle. The light posts were leaning and you could pull some of the fence posts out of the ground by hand. Frost heave was a serious issue at Logan Substation, on the Basin Electric Power Cooperative (Bismarck, North Dakota) system.

To compound the problem, the only outages the engineers could get were short and in the spring and fall, when the ground would be thawing or freezing.

Frost heave created major problems at Basin Electric Cooperative's Logan substation.
Concrete piers were 6 inches to 2 feet out of the ground.
Notice the frost heave particularly evident on the pier at right, above.

Logan Substation is located on a windswept plain, about 100 miles north of Bismarck, ND, where temperatures vary from -40° F in the winter to 100° F in the summer. The frost line is about five or 6 feet down and the soil is mainly clay. The site was wet to begin with and when the substation was built, in 1979, grading (to level the site) created a bit of a depression that was topped with gravel. Drainage has been a serious issue from the start and frost heave has been an ongoing challenge.

HELICAL PILES : Quick fix for frost heave

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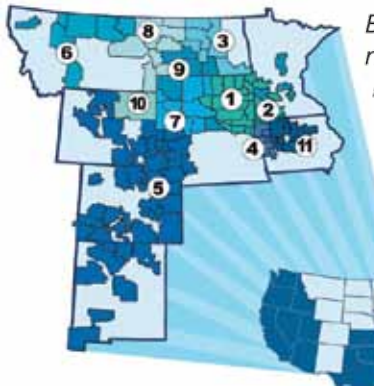
"Frost heave is a problem throughout the substation; basically everything is moving. Some of the small piers, supporting lights posts, had come up almost 2 feet. It was crazy to see the piers heaved that high out of the ground," says Shane Vasbinder, Civil Engineer, Basin Electric Co-op. "The biggest problem was the piers that were supporting the bus-rack structures. The 9-foot concrete piers weren't rising uniformly and the equipment on the racks was at an angle."

A Need for Speed

In 2010, the situation had gotten to the point that something had to be done, but Basin Electric's engineers were not sure what to do. They did not want to move the structures or expend the time or effort needed to remove and replace the existing 9-foot concrete piers. One approach the engineers considered was to remove the structures, grind down the existing piers, pour two concrete piers (one on each side) and then install a beam across the two. The structures could then be re-erected in the same spot. While it would work in theory, it was

At left, a light post at the station sticking about 18" out of the ground. As the superstructures move, conductors connected to them are stretched, including those connected to the substation ground grid.

not a practical solution. They would not be able to get the necessary outages needed to pour concrete and let it harden.



Basin Electric serves members in nine states: Colorado, Iowa, Minnesota, Montana, Nebraska, New Mexico, North Dakota, South Dakota, and Wyoming. The regional areas are divided into 11 membership districts whose directors serve on the Basin Electric Board.

Getting an outage was going to be a challenge. Basin Electric is a G&T co-op that provides power to 135 member co-ops. Its total territory covers 540,000 square miles and stretches from Canada to Mexico. Member companies provide power to 2.8 million consumers in nine states. Logan is a 230kV and 115kV transmission substation, providing power to native load and member co-ops.

"Logan Substation feeds a number of critical regions. As the lines go west, they feed all the new oil development areas. We just can't take extended outages," says Vasbinder. Besides, the only time dispatchers could arrange an outage was during low-load times (the soonest was in October) — late enough in the year that freezing temperatures and snow storms were a real possibility.

Basin Electric needed another solution.

"We had used the A.B. Chance (Hubbell Power System) Helical Piles before – to fix transmission structures in the middle of winter – and that looked like our best option. We couldn't take a long, extended outage to go in and pour concrete," says Vasbinder. "If we used Helical Piles, we could drill the anchors down and, later that day or the next day, put the structures back up. We could get a whole area done in a week, at most. That was about as long of an outage we could get. Further, we could work in October and not worry about heating enclosures for concrete, so we went with the Helical Piles."

Helical Piles: Fast and Winter Friendly

To begin, Basin Electric contacted Lee Goen, Senior Chance Anchoring Application Engineer, for help. "The co-op was able to provide all the necessary load information, including vertical (or axial) loads and overturning moments. The axial loads were minimal, but, due to strong winds at the site, the moment loads were significant. And, Basin Electric provided bore logs from the site that let me determine the strength of the soil, so I could pick out the right pile," says Goen. It was possible to replace each foundation with a single Helical Pile, but Basin Electric's engineers decided to install two, on either side of the original foundation, perpendicular to the frame. They installed a grade beam across the two and re-erected the structures in the original locations.

The Helical Piles used at Logan Substation are 14-feet long, consisting of two 7-foot sections, so they could be installed while nearby bus-work was still in place. (That area of the substation was, obviously, de-energized.)

After taking off the top 2 feet of the existing concrete foundation, the contractor installed two Helical Piles — one on either side.

An Aggressive Schedule

Working with the dispatchers, Basin Electric was able to schedule a few outages. The engineers broke the work into phases and hired High Mark (Piedmont, SD) to install the Helical Piles.

"The concrete foundations had not heaved at the same rate. Some of them were up more than others. In some less serious cases, we just adjusted the cross members, so that they and the equipment on them were level, again. In more serious cases, we had to replace the concrete piers with Helical Piles and re-install level structures," says Megan Milbradt, Civil Engineer, Basin Electric Coop.

"We decided to focus on the worst foundations, first. We looked at our survey and picked a number of foundations that had heaved significantly and were in groups. We had one area with eight foundations that were in really bad shape and decided to fix those during the first outage — to see how it went," explains Milbradt.

"We got the first outage in October 2010. It was cold at that time, but the ground wasn't completely frozen," says Milbradt.

First, spotting the precise location for a Helical Pile's lead section, then the drive tools engage the box coupler at its top.

When the lead section is torqued into the ground, the Helical Pile's baseplate section is added by bolting together their box couplers.

Then the proper drive tool is attached and the entire Helical Pile is torqued to grade.

Vertical alignment is maintained by using a carpenter's level periodically during the process.

After the Helical Piles were installed, a welded grade beam was bolted across the pair. To align the beam's middle plate so the bus structure could be re-installed where it originally was, a magnetic-base drill was used to locate appropriate bolt holes in the pier bases.

"Hubbell Power Systems sent a representative, Jason Herron, out to the field to help us get started and oversee the contractor . . . just in case we ran into any problems, which we didn't. We have a really good working relationship with Hubbell Power Systems," says Milbradt.

It is not unusual for AB Chance (HPS) to send a representative to a job site, says Jason Herron, Chance Anchoring Application Engineer. "I went out the day before they installed the piles. On the first day, the workers took down the bus work and began demolition of the concrete piers. On the second day, High Mark workers started installing the Helical Piles. I was there to answer any questions and help with the installation, because this particular contractor had never installed our Helical Piles before. So, I directed them on how to put the tooling together and how to attach it to their drill rig."

"It isn't hard to get a new contractor up to speed. The biggest thing is working with their equipment. Most people think that whenever you install a Helical Pile, you need a large drill rig or something similar. This contractor came out with this large drill rig and that is not typically what an installer needs. The contractors that install a lot of Helical Piles usually install a torque motor on a skid steer loader, or for these larger diameter piles, they will generally put a higher capacity torque motor on an excavator," says Herron.

"Helical Piles have to be installed at a certain rate—typically eight to 20 revolutions per minute. For every revolution the anchor will embed itself 3 inches into the ground. If you drill too fast, it will have the effect of

auguring the hole out. You are actually disturbing the soil and you don't get the bearing pressure you need. If you go too slowly, you are just wasting your time. At Logan Substation, the equipment (designed to drill holes) was turning a bit too fast. So, we had to work with the operator to get it slowed down. Typically, this is achieved by adjusting the flow rate on the machine or slowing the RPM or the machine. They made the adjustments and averaged about 14 revolutions per minute," says Herron.

During the first outage, work began on Tuesday and finished on Saturday. In that time, the co-op finished eight foundations and that included removing the structures, jack-hammering out a couple feet of the existing foundations and clearing the site, drilling in the Helical Piles and putting the structures back up.

During a second outage in October, Basin Electric Co-op completed work on ten more foundations. Then, winter arrived in earnest and a third outage, scheduled for December, had to be cancelled. The rest of the work will be completed in the spring.

"Overall, using the Helical Piles was a good solution for us. Most importantly, we didn't need long outages. The expense was most likely less than pouring concrete and we didn't have to pour concrete in cold weather. We got the results we needed," says Milbradt.

For details on CHANCE® Helical Foundations, contact your local Hubbell Power Systems representative or see Catalog Section 4B on our web site.

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Hubbell Power Systems (HPS) manufactures a wide variety of transmission, distribution, substation, OEM and telecommunications products used by utilities. HPS products are also used in the civil construction, transportation, gas and water industries. Our product line includes construction and switching products, tools, insulators, arresters, pole line hardware, cable accessories, test equipment, transformer bushings and polymer precast enclosures and equipment pads.

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